Back-to-basics

Part 2 Axial thrust position monitoring

In a previous *Orbit*, we published "Axial thrust position monitoring - Part 1." That article explained the concept of thrust bearing clearance, including cold and hot float zones and described the important relationship between a proximity probe transducer's linear range and thrust bearing clearance. Copies of Part 1 are available upon request by checking the appropriate box on the Reader Service Card.

This article will complete the subject by discussing the techniques required for effective monitor system operation, including both probe installation (proper gap setting) and monitor calibration. Examples of two common setup techniques will be presented - meter zero in the center of the float zone and meter zero at the active side of the bearing. The article concludes with recommendations for establishing alarm setpoints in order to achieve proper machine protection, insure monitor system integrity, and build operator confidence in the monitor system.

Part 1 of this article established the relationship between the transducer's linear range and the thrust bearing's float zones. Figure 1 illustrated the situation, and the same figure is repeated here. As shown, the transducer's linear range is 80 mils (2 mm), from a minimum gap distance of 10 mils (0.25 mm) to a maximum gap of 90 mils (2.25 mm). Correspondingly, the linear range minimum gap voltage is −2.0 volts, while the maximum is −18.0 volts. Thus the center of the probe's linear range is at a gap distance of 50 mils (1.25 mm) and a voltage of −10.0 Vdc.

Ideally, the center of the transducer's linear range should correspond to the center of the rotor's float zone (either cold or hot; both have the same center). However, it is difficult to position and hold a rotor at the exact center of its float zone. A much easier technique is to position the rotor (thrust collar) at one side or the other (typically the active side) of the thrust bearing, and then install the probe at the proper gap distance/voltage.

Note: "Position" the rotor against the bearing face (as close as possible to) with the same force as it will exert on the bearing under normal operating conditions. Hydraulic force is a useful tool for this purpose.

Using the example in Figure 1, if the cold float zone is 16 mils (0.4 mm), then the rotor will be 8 mils (0.2 mm) away from center if the thrust collar moves to either side (face) of the thrust bearing. This corresponds to a change of 1.6 Vdc away from center. Thus, with the thrust collar at the active side of the bearing (away from the probe, in this example), the appropriate probe gap distance would be 58 mils (1.45 mm), with a corresponding gap voltage of −11.6 Vdc.

Rotor axial position versus meter reading

After establishing the correct relationship between the probe gap and the thrust collar position within the bearing, the third variable in the system must be addressed: the meter reading. After all, a control room operator does not see the actual rotor position in the bearing, nor the probe gap voltage directly. The operator's interface to the measurement system is the meter readout. It is therefore necessary to relate correctly the probe gap voltage/thrust collar position to the meter.

Most manufacturers' thrust position monitors typically display shaft axial position (displacement) under normal monitor operation. This is also true for Bently Nevada thrust position monitors. However, with most of our monitors, the operator can actuate a front panel switch to read probe gap voltage as well.

Proper monitor system setup cannot omit one important step: calibration. Proper calibration insures that a measured change in probe gap voltage and a corresponding change in displacement on the thrust monitor reading accurately represent a known change in rotor axial displacement.

Perform thrust transducer calibration before installing the thrust probe in the machine. Using an accurate spindle micrometer (with a target of the same material as the shaft), transducer calibration insures that a measured change in transducer output voltage properly reflects a known change in shaft displacement. This procedure verifies the transducer's sensitivity. The standard sensitivity is 200 millivolts per mil (8 volts per millimetre), although some systems use 100 mV/mil (4 V/mm).

Calibrate the monitor before probe installation, using the actual probe which will be installed in the machine. If the probe is already installed, use an equivalent probe (same tip/coil diameter and electrical cable length).

There are two techniques commonly used for thrust monitor (meter zero)—setup. Both methods are equally valid. The difference in the two is the resultant meter reading when the rotor is in its normal operating position.

Method 1: Meter zero equals float zone center: One method is to setup the

monitor so a zero (center) reading on the meter represents a rotor position in the center of the thrust bearing clearance. See Figure 2. With this setup, since rotors rarely operate in the center of the thrust bearing clearance, a normal meter reading (with the machine at normal operating conditions) would not be zero. A typical reading would be a displacement away from zero (usually in the active thrust direction) equal to one-half of the rotor's hot float zone.

Using this technique for the above example, a typical reading would be 12 mils (0.3 mm) in the active direction on the meter (or perhaps slightly less, due to the oil film between the thrust collar and the bearing surface). A reading of 12 mils would correspond to a probe gap voltage of −12.4 Vdc. A reading of 12 mils (0.3 mm) in the inactive direction on the meter would represent a rotor position against the inactive side of the thrust bearing clearance (and a probe gap voltage of −8.6 Vdc).

The advantage of this setup is the logical relationship between the linear range of the proximity transducer and the meter range. The center of the probe's linear range is equal to the center of the meter scale (zero). This method makes the instrument technician's job easier because all thrust monitors can use the same reference (meter zero equals float zone center). The disadvantage is that if various machines have different hot float zones, as they almost always will, then the normal thrust monitor reading for each machine will be different. This may make the control room operator's job a bit more difficult.

Method 2: Meter zero equals float zone active side: The objective of the second technique is specifically to overcome the disadvantage of the previous method. With this technique, the objective is to have thrust meters for all machinery (assuming normal machine conditions) read about the same on the meter, nominally zero, or close to zero. This method makes the operator's job easier; only those meter readings which vary significantly from zero are cause for concern. However, the disadvantage is that this makes the instrument technician's job slightly more difficult, since the thrust monitor for each machine must be setup differently.

The procedure is to consider the size of the hot float zone and adjust the meter so it reads zero with the rotor against the active side of the bearing (ideally, in its

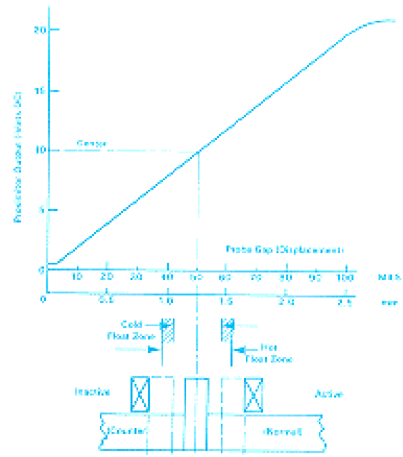

Figure 1
Relationship between proximity probe linear range and available motion of thrust collar within thrust bearing clearance.

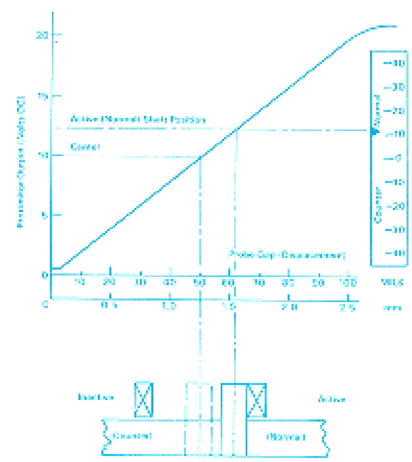

Figure 2
Meter zero equals thrust collar in center of float zone.

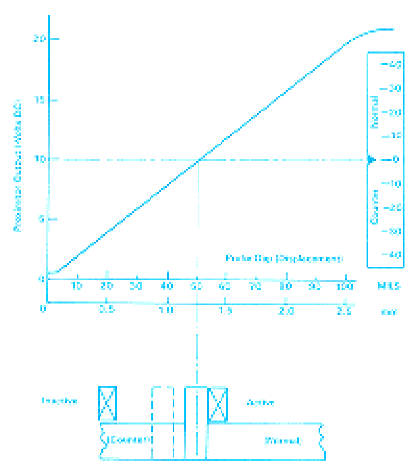

Figure 3
Meter zero equals thrust collar against active side of thrust bearing.

normal operating position in the hot float zone). See Figure 3. One problem with this procedure is that it is difficult to simulate the hot float zone condition with the machine shutdown (cold condition). The meter therefore must be adjusted to some other rotor position reference which can be simulated with the machine down.

Again using the above example, if the hot float zone is 24 mils (0.6 mm) and the cold float is 16 mils (0.4 mm), this represents a difference of 8 mils (0.2 mm), or 4 mils (0.1 mm) on either side of the bearing clearance. Thus, with the machine down and the thrust collar positioned at the active side of the bearing (cold float zone), adjust the meter to read 4 mils (0.1 mm) in the inactive direction. This corresponds to a probe gap voltage of −11.6 Vdc.

When the machine reaches normal operating conditions (with the collar against the active side of the bearing — hot float zone), the meter should read zero, with a probe gap voltage of −12.4 Vdc. Note that the meter will read exactly zero only if the exact difference between the cold and hot float zones is known. If this difference is only an estimate, or if for some reason the long hot float zone changes slightly from one run of the machine to the next, then the meter may not read exactly zero. In any case, as the estimate of cold versus hot float zone size is close, then the meter reading will be close to zero using this method.

Methods 1 and 2, Similarities and Differences: As stated above, Methods 1 and 2 differ in the resultant meter readings with the rotor in its normal operating position. Under typical machine operation, Method 1 will result in a meter reading not equal to zero, while Method 2 will result in a meter reading equal to (or at least close to) zero. It is also important to note the similarities in the two setups. Using either technique, the relationship between the rotor axial position and the probe linear range is the same. In both cases, the probe is adjusted so the center of the transducer's linear range is at the center of the bearing clearance (float zone).

Notice the similarity by comparing Figures 2 and 3. In both setups, the center of the probe's linear range (−10 Vdc) is at the center of the bearing clearance, and when the rotor is in its normal operating position the probe gap voltage is −12.4 Vdc.

A final word of caution: Once the proper shaft axial position/probe gap/meter reading relationship is established, do not change these references, especially after machine startup. For example, assume Method 2 above is being used in an attempt to have a meter reading of zero under normal machine condition. Also assume that after startup, the reading not exactly zero because the hot float zone estimate was slightly incorrect. In this situation, do not (re)adjust the meter and do not (re)adjust the probe in order to obtain a meter reading of exactly zero. If the meter is readjusted after startup, all original references, once so carefully established, will be lost.

A set of undisputed data for these reference variables can be helpful in the future, especially if monitor system troubleshooting is ever required. For example, if the meter reading changes over time and there is some doubt about whether this represents actual shaft motion or not, then the monitor reading must be verified. With the original set of data intact, any meter reading can be directly referenced to a specific probe gap voltage, which in turn can be referenced to a known shaft position within the thrust bearing clearance. If the meter or probe was readjusted after machine startup, then there is no way to be sure the meter reading accurately represents actual shaft position.

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Monitor alarm setpoints

When considering thrust position monitor alarm setpoints, recognize that the objective of monitoring this parameter is not necessarily to save the thrust bearing completely from damage. The primary objective is to prevent severe axial rubs and machine destruction. In effect, some thrust bearing wear is acceptable under most operating conditions. Thrust bearings typically have enough babbitt (white metal) to sustain babbitt loss long before the rotor is in danger of an axial rub. Therefore, it is reasonable to allow for some babbitt loss to occur before reaching the first alarm setpoint.

Some babbitt loss is even desirable from a monitoring standpoint. If a thrust monitor alarm occurs, and visual mechanical inspection reveals no damage to the thrust bearing, then the operators and everyone else in the plant will lose confidence in the monitor system. It is therefore, desirable to adjust the first alarm setpoint so it actuates when measurable or visual babbitt loss has already occurred.

By understanding the above discussion and recognizing the concept of cold versus hot float zones, then establishing monitor alarm setpoints is relatively straightforward. With most monitor systems, there are four alarm setpoints: first and second level alarms in each of the active/normal and inactive/counter bearing directions. Set the first level alarm (Alert) beyond the limit of the hot float zone in each direction so some babbitt will be removed before the alarm setpoint actuates. Set the second level alarm (Danger) to actuate after even more babbitt loss, but well before the rotor is in danger of an axial rub.

For the example shown, Alert alarms are set to actuate after approximately 6 mils (0.15 mm) of babbitt loss. These setpoints are the same for both the active and inactive directions, and represent probe gap voltages of −13.6 and −6.4 Vdc, respectively. The Danger alarms are also set the same for both directions and represent an additional 10 mils (0.25 mm) of babbitt loss. The corresponding probe gap voltages are −15.6 and −4.4 Vdc, respectively.

For further information on axial thrust position monitoring, check the Thrust Monitoring box on the Reader Service Card. ■